

# Dialytic Support of Acute Kidney Injury (AKI)

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# ***Objectives***

***When to start ?***

***What Modality ?***

***HOW can we do it ?***

## **Definition of AKI**

**Rapid deterioration of renal functions resulting  
in the accumulation of nitrogenous wastes  
such as urea **and** creatinine.**



# RIFLE Classification

	GFR criteria	Urine output criteria
<b>Risk</b>	1.5-fold increase in $S_{\text{creat}}$ or GFR decrease >25%	UO <0.5 mL/kg/h for 6 h
<b>Injury</b>	Two-fold increase in $S_{\text{creat}}$ or GFR decrease >50%	UO <0.5 mL/kg/h for 12 h
<b>Failure</b>	Three-fold increase in $S_{\text{creat}}$ GFR decrease >75%, $S_{\text{creat}} \geq 4$ mg/dL, or acute rise in $S_{\text{creat}} \geq 0.5$ mg/dL	UO <0.3 mL/kg/h for 24 h or anuria for 12 h
<b>Loss</b>	Complete loss of kidney function >4 weeks	
<b>ESKD</b>	End-stage kidney disease (>3 months)	

# Stage-based management

## AKI Stage

### General Principles

#### Stage 1 (**Risk**)

**Risk for more severe AKI**  
**Monitor (prevent progression)**

#### Stage 2 (**Injury**)

**Risk of AKI-related mortality/morbidity high**  
**Conservative therapy)**

#### Stage 3 (**Failure**)

**Highest risk of death**  
**Consider RRT**

**High Risk**

**1  
Risk**

**2  
Injury**

**3  
Failure**

*Discontinue all nephrotoxic agents when possible*

*Ensure volume status and perfusion pressure*

*Consider functional hemodynamic monitoring*

*Monitoring Serum creatinine and urine output*

*Avoid hyperglycemia*

*Consider alternatives to radiocontrast procedures*

**Non-invasive diagnostic workup**

*Consider invasive diagnostic workup*

**Check for changes in drug dosing**

**Consider Renal Replacement Therapy**

*Consider ICU admission*

**Avoid subclavian catheters if possible**

***When to start ?***

# Indications for RRT in critically ill AKI patients

## Renal Indications

### Life-threatening indications

- ➡ **Hyperkalemia**
- ➡ **Metabolic Acidosis**
- ➡ **Pulmonary edema**
- ➡ **Uremic complications**

Indication	Characteristics	Absolute/Relative
Metabolic abnormality	BUN > 76 mg/dl (27 mmol/L)	Relative
	BUN > 100 mg/dl (35.7 mmol/L)	Absolute
	Hyperkalemia > 6 mEq/L	Relative
	Hyperkalemia > 6 mEq/L with ECG abnormalities	Absolute
	Dysnatremia	Relative
	Hypermagnesemia > 8 mEq/L (4 mmol/L)	Relative
	Hypermagnesemia > 8 mEq/L (4 mmol/L) with anuria and absent deep tendon reflexes	Absolute
Acidosis	pH > 7.15	Relative
	pH < 7.15	Absolute
Anuria/oliguria	Lactic acidosis related to metformin use	Absolute
	RIFLE class R	Relative
	RIFLE class I	Relative
	RIFLE class F	Relative
Fluid overload	Diuretic sensitive	Relative
	Diuretic resistant	Absolute



# **Indications are open to interpretations**

- **How volume overloaded?**
- **What is the definition of diuretic resistance?**
- **What should potassium level be?**
- **How severe for metabolic acidosis?**



# ***Dialysis Interventions for Treatment of AKI***

- **5.1.1**: ***Initiate RRT emergently*** when **life-threatening** changes in fluid, electrolyte, and acid-base balance exist. (Not Graded)
- **5.1.2**: Consider the ***broader clinical context***, the presence of conditions that can be modified with RRT, and ***trends of laboratory*** tests—rather than single BUN and creatinine thresholds alone—when making the decision to start RRT. (Not Graded)

# When to start RRT ?

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Liu et al (29)	2006	IHD & CRRT	Observational	243	BUN ≤76 mg/dL	BUN >76 mg/dL	65	59

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**Higher mortality in the early HD group**

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**Early start CRRT in Post-Traumatic ARF has better survival**



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**No significant differences in survival were observed**



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**The sooner the ARF after surgery is recognized and CVVHDF is performed, the higher the likelihood of the reduction of the hospital mortality**

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**Early RRT seems better**



***What Modality?***



# ***Renal Replacement Therapy in AKI***

- 1. Peritoneal dialysis (PD)***
- 2. Intermittent Hemodialysis (IHD)***
- 3. Slow Low-Efficiency Daily Dialysis (SLED)***
- 4. Continuous Renal Replacement Therapy (CRRT)***
  - Slow Continuous Ultrafiltration (SCUF)***
  - Continuous Venovenous Hemofiltration (CVVH)***
  - Continuous Venovenous Hemodialysis (CVVHD)***
  - Continuous Venovenous Diafiltration (CVVHDF)***



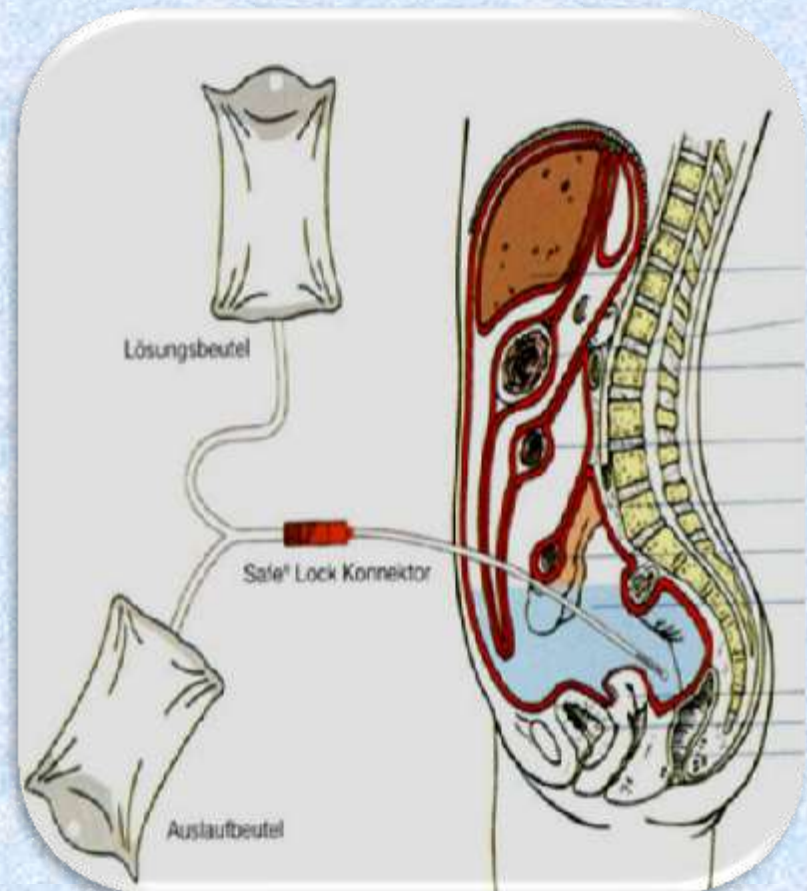
# **Peritoneal Dialysis (PD) In Akl**

## **Advantages**

- *Hemodynamic stability*
- *Slow correction*
- *Easy access placement*
- *No Anticoagulation*
- *Tolerated in children*

## **Disadvantages**

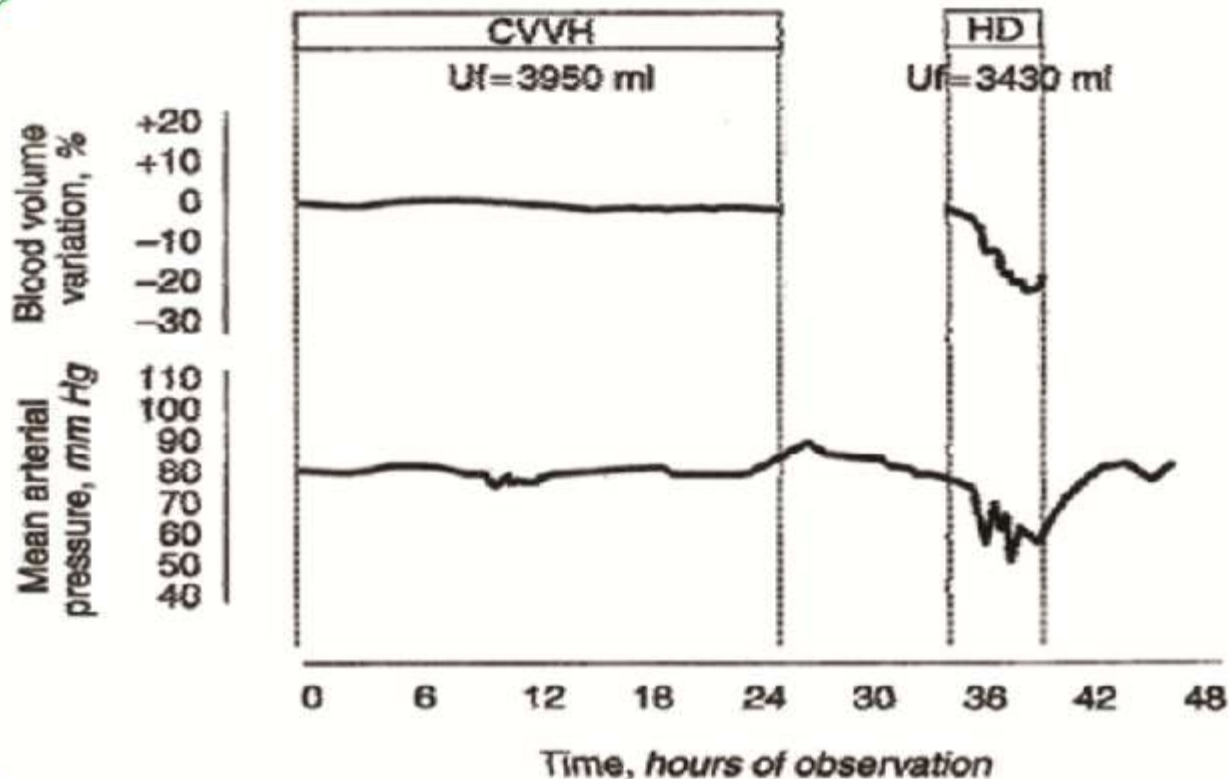
- *Risk of infections*
- *Difficulty to use with abdominals surgery*
- *Logistics*



# *Potential Advantages of **CRRT***

- ➡ *Homodynamic stability*
- ➡ *Recovery of renal function*
- ➡ *Brain edema*
- ➡ *Biocompatibility*
- ➡ *Removal of cytokines*
- ➡ *Nutritional support*
- ➡ *Correction of metabolic acidosis*

## **CVVH** Avoids Hypertensive Episodes



**Ronco C et al Kidney Int 56 ( suppl 72 ) s-8-s-14 , 1999**

## Dialysis Interventions for Treatment of AKI

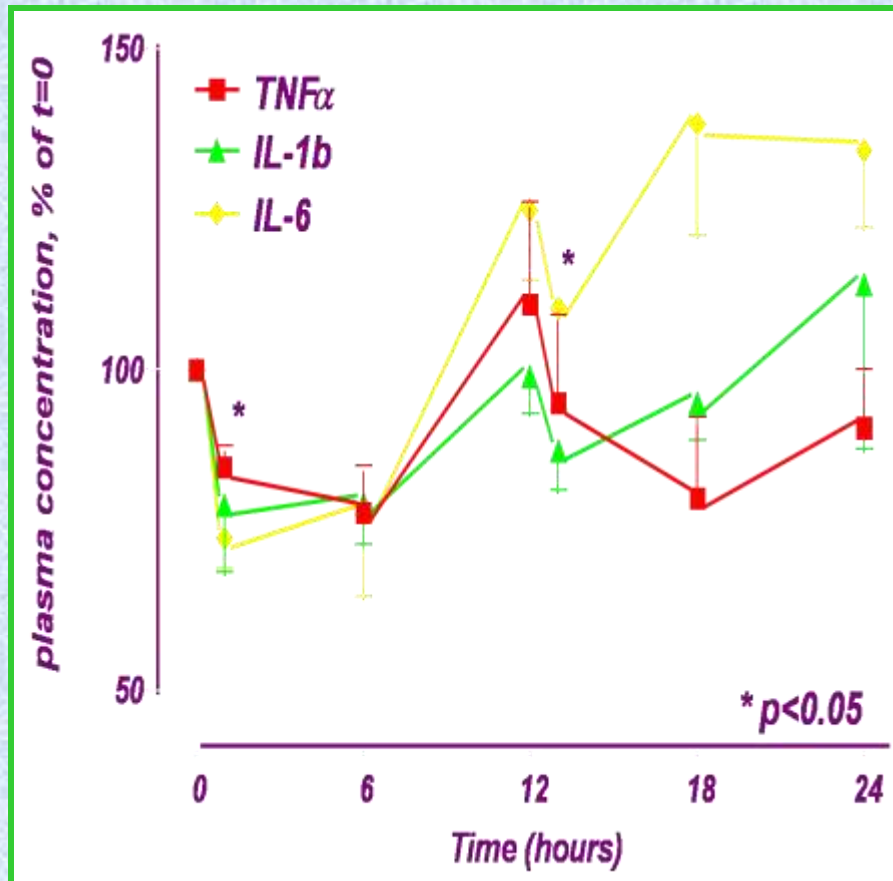
- **5.6.2:** We suggest using **CRRT**, rather than **standard intermittent RRT**, for hemodynamically unstable patients. (**2B**)
- **5.6.1:** Use **continuous and intermittent RRT** as **complementary therapies** in AKI patients. (**Not Graded**)



## ***Recovery from ARF in IHD vs CRRT***

<i><b>Study</b></i>	<i><b>Modality</b></i>	<i><b>% recovering renal function</b></i>
<i><b>SUPPORT</b></i>	<i><b>IHD*</b></i>	<i><b>67%<sup>**</sup></b></i>
<i><b>Morgera et al.</b></i>	<i><b>CRRT</b></i>	<i><b>90%</b></i>
<i><b>Ronco et al.</b></i>	<i><b>CRRT</b></i>	<i><b>90%</b></i>
<i><b>Mehta et al.</b></i>	<i><b>IHD</b></i>	<i><b>59%</b></i>
	<i><b>CRRT</b></i>	<i><b>92%</b></i>
<i><b>BEST Kidney†</b></i>	<i><b>IHD</b></i>	<i><b>65%</b></i>
	<i><b>CRRT</b></i>	<i><b>89%</b></i>

## *removal of Cytokine*



➤ *The elimination of inflammatory mediator occurs only during the 1<sup>st</sup> hour after application of new filter.*

➤ *Cytokines removal capacity of currently available membranes hardly matches the production observed in severely affected septic patients.*

# Is there an alternative to CRRT ?

## ***Slow Low-Efficiency Daily Dialysis (SLED)***

- Typically performed over 6-12 hours
- Can be performed with a conventional dialysis machine
  - A little less labor intensive
  - Requires less training/startup

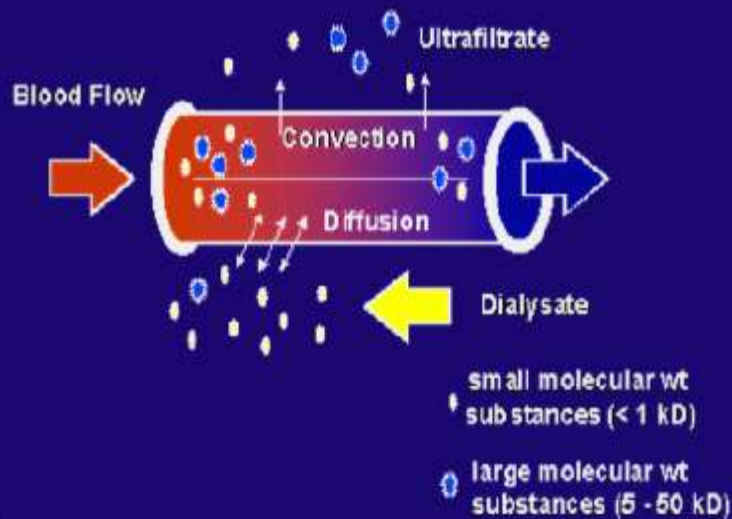
## ***Slow Low-Efficiency Daily Dialysis (SLED)***

- Major advantages: flexibility, reduced costs, low or absent anticoagulation
- Similar adequacy and hemodynamics
  - ✓ One small study (16 pts) showed slightly higher acidosis and lower BP (**Baldwin 2007**)
  - ✓ VA trial (**Palevsky NEJM 2008**) suggests similar outcomes as CRRT and IRRT.



# ***What are the modalities of CRRT?***

## **Convection vs. Diffusion**



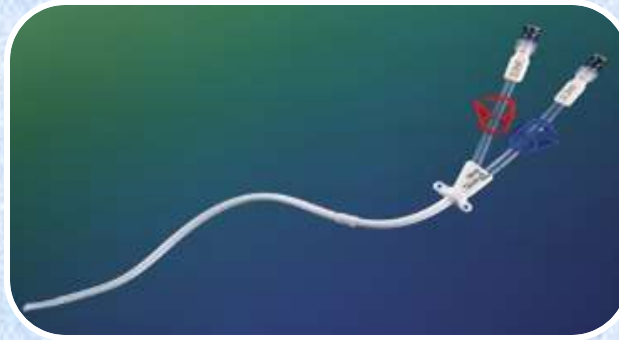
<b><i>Mode of therapy</i></b>	<b><i>Principle method of solute clearance</i></b>
<b><i>CVVH</i></b>	
<b><i>CVVHD</i></b>	
<b><i>CVVHDF</i></b>	
<b><i>SCUF</i></b>	

## ***How we can do it ?***

Processes of care, more pertinent to Nephrologists:-

- ✓ Vascular Access
- ✓ Membrane characteristics
- ✓ Solution
- ✓ Anticoagulation
- ✓ Dose

# Vascular access



- **5.4.1:** We suggest initiating RRT in patients with AKI via an **uncuffed nontunneled dialysis catheter**, rather than a tunneled catheter. (**2D**)
- **5.4.2:** When choosing **a vein for insertion of a dialysis catheter** in patients with AKI, consider these preferences (**Not Graded**):
  - **First choice:** right jugular vein;
  - **Second choice:** femoral vein;
  - **Third choice:** left jugular vein;
  - **Last choice:** subclavian vein with preference for the dominant side.

# Solutions for CRRT

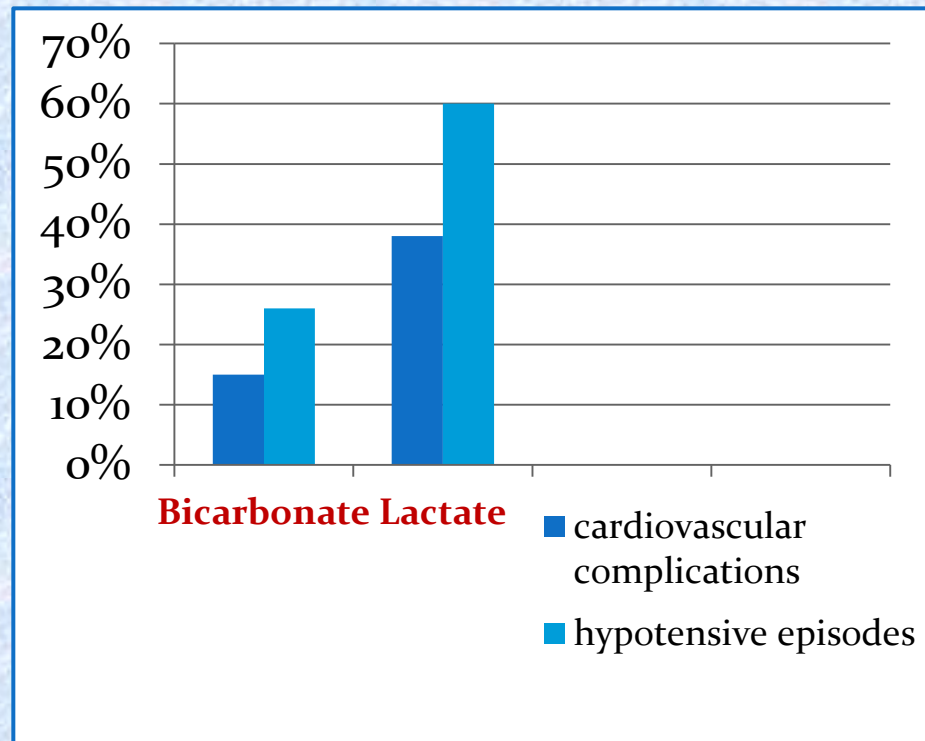
## Bicarbonate versus lactatebased fluid replacement in CVVH

Prospective, randomized study

### • **Results :**

- **Serum lactate concentration was significantly higher and the bicarbonate was lower in patients treated with lactatebased solutions**
- **Increased incidence of CVS events in pts ttt with lactate solution**
  - **Hypotension**
  - **Increased dose of inotropic support**

barenborck and colleague



Barenbrock M et al; Kidney Int (2000)



## Dialysis Interventions for Treatment of AKI

**5.7.3**: We suggest using **bicarbonate**, rather than lactate, as a buffer in dialysate and replacement fluid for RRT in patients with AKI and liver failure and/or lactic acidemia. (**2B**)

# ***The Membrane***

- ***High Flux membrane , synthetic , biocompatible , acting by providing both methods of detoxications:***
  - a) ***Diffusion*** : for low molecular weight toxins.
  - b) ***Convection*** : for large molecules.

**5.5.1**: We suggest to use dialyzers with **a biocompatible membrane** for IHD and CRRT in patients with AKI. (**2C**)

# Anticoagulation

Modality	Advantages	Disadvantages
<b>Heparin</b>	Good anticoagulation	Thrombocytopenia bleeding
<b>LMWH</b>	Less thrombocytopenia	bleeding
<b>Citrate</b>	Lowest risk of bleeding	Metabolic alkalosis, hypocalcemia special dialysate
<b>Regional Heparin</b>	Reduced bleeding	Complex management
<b>Saline flushes</b>	No bleeding risk	Poor efficacy
<b>Prostacycline</b>	Reduced bleeding risk	Hypotension poor efficacy

**5.3.2.1**: For anticoagulation in **intermittent** RRT, we recommend using either **unfractionated or low-molecular weight heparin**, rather than other anticoagulants. (**1C**)

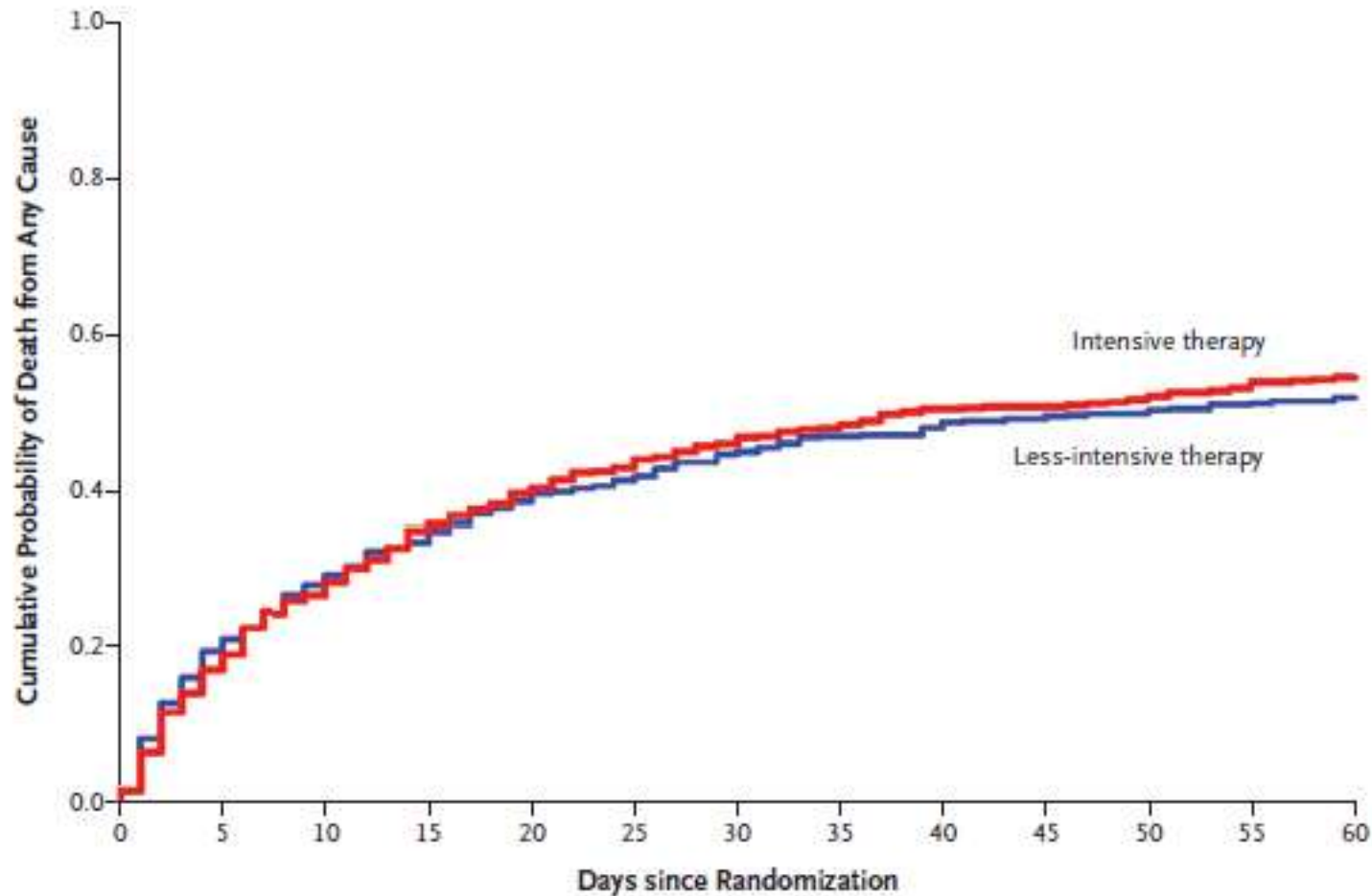
**5.3.2.2**: For anticoagulation in **CRRT**, we suggest using **regional citrate** anticoagulation rather than heparin in patients who do not have contraindications for citrate. (**2B**)



# ***Dose***

## ***Optimal intensity of RRT is controversial***

- RCT of 1124 critically ill pts with AKI and sepsis or at least one organ failure to intensive or less intensive renal-replacement therapy
- Hemodynamically unstable pts received CRRT or SLEDD, stable pts IRRT
- ✓ Intensive RRT= IRRT or SLEDD 6x/wk or CRRT at 35 ml/kg/hr
- ✓ Less intensive RRT= IRRT or SLED 3x/wk or CRRT at 20 ml/kg/hr

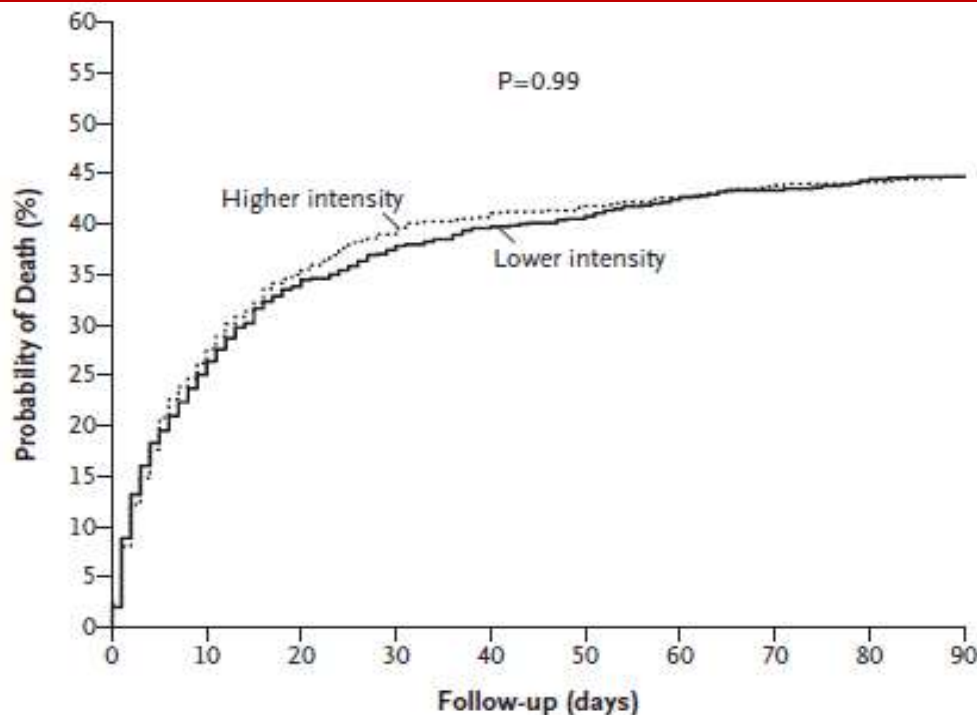


**No difference in mortality**

VA/NIH Acute Renal Failure Trial Network. (NEJM 2008;359:7):

# The RENAL Replacement Therapy Study

- 1508 Critically ill patients with AKI on CVVHF were randomized to:-
  - ✓ **low** (25 mL/kg/hr – 747 patients)
  - ✓ **high** intensity (40 mL/kg/hr – 761 patients) effluent rates.



There was no difference in 90 day mortality rate (44.7%) or the need for RRT at 90 day between the two treatment groups.

**5.8.1**: The **dose of RRT to be delivered** should be prescribed **before starting** each session of RRT. (**Not Graded**)

We recommend **frequent assessment of the actual** delivered dose in order to adjust the prescription. (**1B**)

**5.8.2**: Provide RRT **to achieve the goals of electrolyte, acid-base, solute, and fluid balance that will meet the patient's needs.** (**Not Graded**)



# Conclusions

- ✓ *Data from high quality RCTs are lacking*
- ✓ *The current trend is to provide RRT earlier*
- ✓ *There may be a recovery advantage to using CRRT vs. HD for initial management of AKI but no difference on mortality*
- ✓ *Dose: No benefit to “intensive” therapy*

**Dialytic Support of *AKI* = Individualization**

# ***Thank you***



A word search puzzle with the word 'MARKETING' highlighted in red. The puzzle consists of a grid of letters arranged in 10 rows and 10 columns. The letters are as follows:

I	N	N	O	V	A	T	I	O	N
S	U	C	C	E	S	S			
E	V	A	L	U	A	T	I	O	N
D	E	V	E	L	O	P	M	E	N
G	R	O	W	T	H				
S	O	L	U	T	I	O	N		
P	R	O	G	R	E	S	S		
M	A	R	K	E	T	I	N	G	

The word 'MARKETING' is highlighted in red, spanning the 8th row from column 1 to column 8.